Lean production and agile organizaton : the link between supply chain and sustainable development

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LEAN PRODUCTION AND AGILE ORGANIZATION: THE LINK BETWEEN SUPPLY CHAIN AND SUSTAINABLE DEVELOPMENT

While there are separate streams of established research on lean production, agile organization, and sustainable supply chain, the idea is to address the intersection of these three strategic initiatives in order to find synergies and competitive advantage for companies. The goal of the mission is to explore the link between supply chain and sustainable development with the insights of two main paradigms in the changing competitive environment: lean and agility. On the one side, the focus of the lean approach has essentially been on the elimination of waste and all non-value activities. On the other side, a key characteristic of an agile organization is flexibility at different echelon. The concern is to analyze how companies could manage the lean and agility principles in the supply chain with sustainable development at the different stage of the supply chain.

Keywords: Sustainable development/Supply chain management/Manufacturing / Lean/ Agile/ Leagile

INTRODUCTION

Due to global economy, volatile markets, competitive pressure, shortened-life-cycle product, more rigorous quality and quicker response requirements, rising ecology consciousness: the survival of many companies depends on the ability to continuously improve quality while reducing costs. Manufacturing systems have to respond to continuous changes and sustainability requirements. Therefore significant interest has been shown in recent years in the idea of “lean manufacturing” (Womack *et al.*1990) and the wider concepts of the “lean enterprise” (Womack and Jones, 1996). Lean operations with low inventory have become an essential practice. Many organizations have adopted the lean thinking paradigm in order to optimize performance and competitive advantage. Then, in recent times, the emergence of customer-driven markets has resulted in rapid changes to strategies adopted by organizations. The agile manufacturing paradigm has been highlighted as an alternative to leanness (Richards, 1996). Agile manufacturing systems work in a constantly changing global market, particularly assembly systems at the last stage of product differentiation. In these changing conditions, one of the more interesting debates in recent years was about the creation of lean production and agile organization as the key to survival for companies. Indeed, in some situations it is advisable to utilize a leagile paradigm to ensure optimal supply chain performance (Mason-Jones *et al*.2000). Meanwhile, in the wake of concerns regarding climate change, pollution and non-renewable resource constraints, sustainability is becoming a key issue for manufacturing strategy and supply chains. These paradigms (lean, agile, leagile and sustainable) should not be considered alone or in isolation within the supply chain although they show up with opposed characteristics. Tradeoffs between these management paradigms may help organization and their supply chain to become more competitive and sustainable. The sustainability paradigm has opened the gate for revisiting various established strategies of supply chain management to reassess their viability with new angle of sustainability in general and greening specially (Stonebraker *et al*.2009).

Consequently, in this context, how lean production and agile organization meet supply chain and sustainable development? The purpose of this study is to present the relationship between lean production and agile organization in a sustainable supply chain perspective. First, we will present the link between sustainable development paradigm and supply chain management in order to analyze in a second part, the differences between the two paradigms lean production and agile organization according to sustainable supply chain and finally we will study how the two paradigms combined enable highly competitive sustainable supply chains.

I- THE SUSTAINABLE DEVELOPMENT PARADIGM AND THE LINK WITH SUPPLY CHAIN

I-1-DEFINITION

Sustainable development: The Brundtland commission (World Commission on Environment and Development 1987) defined the term of sustainability as: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainability can be linked with diverse issues. "Sustainability can mean different things : some see it in terms of long-term viability, generally with an environmental perspective, some see a dynamic nature in sustainability, some see it simply as lasting change, which is the way in which we will use it here "(Bicheno and Holweg, 2009). The study is especially on corporate sustainability which has been defined as a business approach that creates long-term shareholder value by embracing the opportunities and managing the risks associated with economic, environmental and social developments. Corporate sustainability has been focused with attention drawn toward the triple bottom line of "people, profit and planet" (Elkington, 1997, 2004) or "Equity, Environment and Economics" (Anderson 2006; Kleindorfer *et al.*2005)**.** Therefore, the concept of sustainable development is made up of three areas: economic, social and environmental sustainability. For an organization, it is translates as a focus on a respect for: profit-economic; people–social; and environment– environmental. Sustainability emerges as a way of considering the environmental and social values of business decisions alongside their economic value.

Supply chain: In the early 1980s firms realized that their competitiveness was not just determined by what they do, but also by what their upstream suppliers and downstream suppliers were doing. Supply chain capabilities are a significant determinant of competitiveness. "Value chains compete, not individual companies" (Christopher, 2000). "Supply chain is a group of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage"(Harrison, Van Hoek, 2005).

I-2 SUSTAINABLE DEVELOPMENT AND SUPPLY CHAIN

Several factors lead firms to pursue sustainable supply chain practices: pressure from stakeholders (Zhu *et al.*, 2008), environmental standards (Rondinelli and Berry, 2000), effects of environmental performance, on firms' reputations (Christmann, 1998), cost reduction (de Brito *et al*, 2008) and competitors (Walker *et al.*, 2008). Moreover, environmental regulations, have forced manufacturers to re-examine the entire lifecycle and environmental impacts on their products. Such compliance efforts have already resulted in cleaner, sager operations, reduced use and acceptable substitutions for hazardous substances, increased product recyclability and recovery, and improved transparency of information available to suppliers, trading, partners, employees, and customers that impact all the supply chain. Consequently, many manufacturing companies are adopting sustainability initiatives in response to internal drivers such as cost reduction, commodity risk management, and upholding corporate culture and external drivers (consumers want the right product at the right cost to the right place at the right time and to be green).Thus, a sustainable supply chain focus requires working with suppliers and customers, analysis of internal operations and processes, environmental considerations in the product development process, and extended stewardship across products' life cycles (Corbett and Klassen, 2006; Mollenkopf, 2006).

But, sustainability issues are adding complexity and risks to the already challenge of managing supply chains such as inventory, cycle time, quality, the costs of materials, production and logistics (Lee, 2010).Three distinct phases of supply chain are identified in the literature (Shukla, 2004) and at each phase of supply chain there are impacts on sustainability measures: Inbound supply chain implies green-design, green sourcing, Manufacturing supply chain or Internal supply chain implies green manufacturing, Outbound supply chain it implies green logistic and green reverse logistic. However,

although sustainability measures often seem worthwhile individually, they may in the grand scheme generate unintended consequences, such as higher financial, social, or environment costs (Lee, 2010). Consequently, these sustainability measures must be coordinated across every stage of the supply chain with adjacent operations. Therefore, the sustainability paradigm may have influence on the supply chain and many supply chain decisions may have impacts on the environment, the social aspects, the communities and the wider supply chain.

II- A DISTINCTION BETWEEN LEAN PRODUCTION PARADIGM AND AGILE ORGANIZATION PARADIGM

"Agility should not be confused with leanness. While leanness may be an element of agility in certain circumstances, by itself it will not enable the organization to meet the precise needs of the customers more rapidly" (Christopher, 2000). That's the reason why it is important to review these two paradigms in order to understand the link with supply chain management and sustainable development.

II-1 THE LEAN PRODUCTION PARADIGM

II-1-1 ORIGINS

The origins of lean manufacturing initiatives can be traced to the Toyota Production System (TPS) and were initiated by Ohno (1978) and Shingo (1989) at Toyota with its focus on the systematic efficient use of resource through level scheduling. The terms "lean production" or "minimum workshop" as Ohno (1978) states, provides a way to do more and more with less and less stock, less human effort, less equipment, les movement of material, less time and less space while coming closer and closer to providing customers with exactly what they want. They used the Japanese word "muda", which were defined as any human activity that absorbs resources but creates no value (Dettmer, 2008).Then, the *lean production* was coined by Womack *et al.* (1990) in their book entitled "The machine that have changed the world" in order to show a better way to organize and manage customer relations, the supply chain, product development, and production operations. This is a vision of a world transformed from mass production to Lean Production which has dominated much of the theory and practice of production systems design. In this context, the idea of "lean thinking" has been expounded by Womack and Jones (1996) and they have emphasized Lean Enterprise rather than Lean Production (Womack *et al.*, 2003).

II-1-2 DEFINITION

The term leanness is often used in connection with lean manufacturing to imply a "zero inventories" just-in-time approach (Christopher, 2000). The main goal is on the systematic identification, reduction and elimination of all waste from the manufacturing processes in order to create value for the customer. It is the single most powerful tool available for creating value while eliminating waste in any organization (Womack and Jones, 1996). It means also developing a value stream to eliminate all waste including time, and to enable a level schedule (Naylor *et al*., 1999). Furthermore, while most of the research stresses that competitiveness of "Lean Production" comes from physical savings on the technical side, a focus has been done on the "psychological efficiency" the peripheral of the organizational mechanism. Lean production system has been one of the competitive advantages for Japanese enterprises, and the cultural element behind it (Recht and Wilderom, 1998). Consequently, "Lean production" is not just a technological system but also a concept implemented throughout the whole company, which especially requires consensus on corporate culture (Wong, 2010). That is the reason why formulating a definition that captures all the dimensions of lean is a formidable challenge (Pettersen, 2009). Today it is the paradigm for operations that can be found in a wide range of manufacturing and service strategies.

II-1-3 PRINCIPLES AND SUPPLY CHAIN STRATEGIES

The lean thinking which includes lean production can be summarized in five principles: “precisely specify *value* by specific product, identify the *value stream* for each product, make *value flow* without interruptions, let the customer *pull* value from the producer, and pursue *perfection.* By clearly understanding these principles, and then tying them all together, managers can make full use of lean techniques and maintain a steady course” (Womack and Jones, 2003). Lean processes create value through the elimination of “waste” in the supply chain (Disney *et al*, 1997). Therefore, lean supply chain strategies focus on waste reduction, helping firms eliminate non-value adding activities related to excess time, labor, equipment, space and inventories across the supply chain (Corbett and Klassen, 2006). At the present time, the lean production paradigm positively impact many markets sectors where cost is the primary order criteria (Hill, 1993). Lean concepts work well where demand is relatively stable and hence predictable and where variety is low and volume is high (Christopher, Towill, 2001).

II-1-4 LEAN PRODUCTION, SUPPLY CHAIN STRATEGIES AND SUSTAINABLE DEVELOPMENT

The causal relationship between lean processes and environmental sustainability has been much debated in literature (King and Lenox, 2001). According to the lean principles, lean production drives more effective and efficient resource utilization, reduces waste and energy consumption, optimizes direct and indirect resources and helps ensure a better product at less cost. The lean model requires less stock, less space, less movement of materials, less time (Shahin, Janatyan, 2010). “Lean thinking must be ‘’green’’ because it reduces the amount of energy and wasted by-products required to produce a given product. Indeed, examples are often cited of reducing human effort, space, and scrap by 50 % or more, per product produced, through applying lean principles in an organization this means that lean’s role is to be green’s critical enabler as the massive waste in our current practices is reduced” (Womack, 2000). Therefore, lean production and sustainable development are often seen as compatible initiatives because of their joint focus on waste reduction (Mollenkopf *et al.,* 2010). As a matter of fact, whereas mass production focuses on big batches, lean focuses on small batches and quick changeover (Womack and Jones, 2003) thereby avoiding all unnecessary production or inventory. So the environmental impact that a shift from mass production to lean production could produce is important. Recent academic research (Hines, 2011) explore how lean can be successfully and sustainably applied to organizations and find the most compelling reason for organizations adopting lean is the economic and environmental benefits of going green. Becoming greener can reduce operating costs significantly and add customer value, two primary tenets of any lean initiative. A lean solution for manufacturing ensures that plants, lines and machines run at peak efficiency, a key component of enabling sustainability. Nevertheless, lean strategies that employ just-in-time (JIT) delivery of small lot sizes can require increased transportation, packaging, and handling that may contradict a green approach (Mollenkopf *et al*., 2010). So, a pure JIT just-in-time approach may have a negative environmental impact. Rothenberg *et al*. (2001) indicates that not all lean processes and waste reduction are positively related to environmental performance or pollution reduction. Furthermore, although lean currently produces environmental benefits and establishes a systematic continual-improvement-based waste elimination culture, lean methods do not explicitly incorporate environmental performance considerations, foregoing some environmental improvement opportunities. Lewis (2000) suggested that being “lean” can curtail the firm’s ability to achieve long –term flexibility and sustainable competitive advantage. It seems that the principles of lean must be linked with another set of initiatives green.

II-2 THE AGILE PARADIGM

II-2-1 ORIGINS

The foundation of what it means to be agile was described in *Agile Competitors and Virtual Organizations*, by Steven Goldman, Robert Nagel and Kenneth Preiss (1995). The concept of agility has its origin in flexible manufacturing systems (FMS) such as machine flexibility, volume, mix, and routing flexibilities (Aitken *et al.*, 2002). Then, the idea of manufacturing flexibility was extended into the wider business context (Nagel and Dove, 1991). The original manufacturing concepts have now been expanded to encompass a much wider management capability to be able to respond to dynamic and turbulent markets (van Hoek *et al.*, 2001). Agility involves not only responding to market changes but also gaining competitive advantage from such volatility (Sharifi and Zhang, 1999). In order to achieve this goal, companies require flexible capabilities in many areas, such as new product development, manufacturing and logistics (Zhang *et al.*, 2002). The supply chain agility is an important integrative element within this management concept (Baker, 2008).

II-2-2 DEFINITION

Bal *et al*. (1999) give the following definition: “Agility is the basis for achieving competitive advantage in changing market conditions”. Agility means using market knowledge and a virtual cooperation to exploit profitable opportunities in a volatile marketplace (Naylor *et al*., 1999). Christopher (2000) indicates that to become more responsive to the needs of the markets requires more than speed but also a high level of maneuverability that today has come to be termed “agility” and provides key elements about the concept: “Agility is a business-wide capability that embraces organizational structures, information systems, logistics processes, and, in particular, mindsets and a key characteristic of an agile organization is flexibility”. Prater *et al.* (2001) give the definition of agility which involves firms being able to respond to change within a useful time frame. However, it is then important to make the distinction between agility, flexibility, responsiveness. Baker (2008) precises that the term “agility” is more normally used at a higher (e.g business wide) level whereas “flexibility” tends to be used at a lower (e.g operational) level. “Responsiveness” only applies to the market or external side (delivery lead-time, volume or output, product mix…), (Bicheno and Holweg, 2009).

II-2-3 PRINCIPLES AND SUPPLY CHAIN STRATEGIES

In general, agility is used in a customer facing sense (e.g in an external context) as the ability to respond and benefit from market changes, for example by suggesting additional inventory buffers, spare capacity, or by postponing the product customization. So, an agile organization means to create supply chains that are able to adapt to changes in demand, product or technology in a short timeframe. “The agile supply chain is an essentially practical approach to organizing logistics capabilities around end-customer demand. “ It is about moving from supply chains that are structured around a focal company and its operating guidelines towards supply chains that are focused on end-customers”(Harrison, Van Hoek, 2011). To be truly agile, a supply chain must possess a number of distinguish characteristics (Christopher, 2000) : market sensitive means the supply chain is capable of reading and responding to real demand, virtual supply chain are information-based rather than inventory based process integration means collaborative working between partners, a confederation of partners linked together as a network. The agile supply chain must develop capabilities for responsiveness and flexibility along the different echelon: manufacturing flexibility (Oke 2005; Kara and Kayis 2004, Schmenner and Tatikonda, 2005), supply chains like warehouse (Baker and Halim 2007), volume flexibility (Salvador *et al*. 2007), supplier role in manufacturing flexibility (Kayis and Kara 2005). Therefore, various dimensions of flexibility in supply chains are identified and categorized such that the first three flexibility dimensions namely product flexibility, volume flexibility and routing flexibility are shop floor capabilities that impact on supply chain (basic flexibility) ; secondly other three

dimensions like delivery flexibility, transshipment flexibility, and postponement flexibility are hierarchically located at company level (system flexibility) ; while other four flexibility dimensions i.e sourcing flexibility, response to market flexibility and distribution or access flexibility are linked to the customer-supplier relationships in the supply chain (aggregate flexibility) (Whadha *et al*.2009a; 2009b). The agile paradigm is needed in less predictable environments where demand is volatile and the requirement for variety is high, where the order winner (Hill, 1993) is availability (Christopher, Towill, 2001). It is about the ability to match supply and demand in turbulent and unpredictable markets.

II-2-4 AGILE ORGANIZATION, SUPPLY CHAIN STRATEGIES AND SUSTAINABLE DEVELOPMENT

The implication of uncertainty for supply chain processes is that they need to respond rapidly to unknown problems and to avoid negative impacts. There are two relevant features of agility: flexibility and complexity (Calvo, Domingo, Sebastian, 2008). Flexibility has been identified as a key productive factor for success or competitive advantage (Suarez *et al*. 1995) but it is required to handle a high variety of products. The variety of products increases the complexity (Wiendahl and Scholtissek, 1994). So, the cost of agility may be linked with actions like buying flexible machines, efficient information systems to share data in real time, capacity enhancement to tackle sudden demand, extramanpower to cope with extra production volumes and decreased time of production, selecting, developing and nurturing of highly dependable multiple suppliers to provide supply flexibility, developing capability for faster transportation in terms of larger fleet, technological upgradation…(Shukla, Deshmukh, Kanda, 2010). Moreover, if a customer requires the company to deliver once a day, the company may not be able to fill up a truck, even through partial truckloads waste energy (Lee, 2010). However, based on flexibility and the response to customer, agility also includes cost reduction, high quality of products and the delivery conditions and service (Goldman and Nagel, 1991). Collaboration with multiple companies, different relationships with business partners or to outsource the work to a third party may be a solution (Lee, 2010).Therefore, it is difficult to assess whether agility with flexibility incorporation adversely affects or collaborates with supply chain sustainability.

III- HYBRID STRATEGIES LEAN PRODUCTION AND AGILE ORGANIZATION: THE LEAGILE PARADIGM

III-1 ORIGINS

While there could be separate streams of established research on lean and agile organization and sustainable supply chain, few authors (Mason-Jones *et al.*, 2000; Christopher, Towill, 2000) have addressed the intersection of these strategic initiatives. The goal is to make connection between supply chain and sustainable in the lean production and agile organizations in order to identify the possible synergies. It is important because firms may be missing synergies available through improved concurrent implementation (Mollenkopf *et al.,*2010).“In pursuing the lean paradigm and agile paradigm in isolation, the power of each paradigm may be lost”(Mason-Jones *et al.*, 2000). Moreover, “lean” and “agile” are not mutually exclusive paradigms and may be married to advantage in a number of different ways. The two approaches can complement each other, and in many cases there is the possibility to find for a “hybrid” lean/agile strategy to be adopted (Christopher, Towill, 2000). The two ideas of lean and agile can be brought together as a hybrid “leagile” solution (Naylor *et al*., 1999). Hybrid strategies can be developed to create cost-effective supply chains and proposes an integrated manufacture/logistics model for enabling the essential infrastructure (Christopher, Towill, 2001). In some situations it is advisable to utilize the *Leagile Paradigm* (Mason-Jones *et al.*, 2000).

III-2 DEFINITION

Leagile is the combination of the lean and agile paradigms within a total supply chain strategy by positioning the decoupling point so as to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the marketplace (Naylor *et al.,* 1997).

III-3 PRINCIPLES AND SUPPLY CHAIN STRATEGIES

Basically, the agile organization is adopted where demand is volatile and lean manufacturing adopted where there is a stable demand. Both agility and leanness demand high levels of product quality and total lead-time has to be minimized to enable agility, as demand is highly volatile and thus difficult to forecast (Christopher, Towill, 2000). Practical ways of combining lean and agile paradigms could be adopted by different strategies like the de-coupling point. The aim is to be lean up to the de-coupling point and agile beyond it, (Hoekstra and Romme 1992). Mason-Jones *et al.* (1999) developed that many supply chains can adopt a "lean" capability up to a given downstream process, and then adopt an "agile" capability thereafter. This enables high productivity, low cost processes to start with, followed by responsive processes to allow high levels of customization thereafter. So, lean material flow is upstream of agile materiel flow. Hence, Lean precedes Agile on two counts; geographically and temporally. According the taxonomy for pipeline selection (Christopher, Peck, Towill, 2006), a matrix suggests that there might be four possible generic supply chain strategies according to three-dimensional classification (products, demand, replenishment lead-times): Lean (plan and execute), leagile (postponement), lean (continuous replenishment), agile (quick response). One such "hybrid" solution is to utilize lean principles when designing supply chains for predictable standard products and agile principles for unpredictable or "special" products ; lean supply chains where service is the order winner and agile supply chains where service is the order winner as described by Mason-Jones *et al*.(2000). It may be that total demand for a product can be separated as "base" and "surge" demand. Base demand is more predictable and less risky so lean principles can be applied, using agile approaches to cope with surge demand (Christopher, Peck, Towill, 2006). It is also likely that products may require different kinds of pipeline according to their position within the product life cycle.

III-4 LEAGILE ORGANIZATION, SUPPLY CHAIN STRATEGIES AND SUSTAINABLE DEVELOPMENT

As lean production and agile organization combines the benefits of both supply capabilities, is it also the case for the benefits of the sustainable supply chain? So, how theses different paradigm lean production and agile organization, combining together, could have impact on sustainable development? As it has been mentioned before, according to the links between each of two paradigms and sustainable development, Lean production and agile organization may have synergies and conflicts about sustainable supply chain. Indeed, leagile paradigm may add to complexity of managing the sustainable supply chain due to different environment impact. There could be divergence and convergence according to the different targeted markets. For example, a reduction in system resources may negatively affect the supply chain's flexibility. Moreover, a supply chain may be currently utilizing its resources efficiently, and producing the desired output, and have sustainable effects but will the supply chain be able to adjust to changes like product demand, supplier shortages, manufacturing unreliability…with the same sustainable effects? From these perspectives, lean production and agile organization might have contradictory sustainable effects. According to this conflict, firms may be able to identify trade-offs or develop solutions that mitigate undesirable consequences (Mollenkopf *et al*., 2010). There is a need to develop a system approach to understand how firms can best manage these concurrent paradigms to optimize the sustainable supply chain as a whole. The green supply chain literature has examined the importance of working across the supply chain with both customers and suppliers on environmental initiatives, which has been shown to lead to improved firm performance (Vachon and Klassen, 2006b). Companies should pursue broader

structural change than they typically do. These may include sweeping innovations in production processes, the development of fundamentally different relationships with business partners that can evolve into new service models (Lee, 2010). More research on the subcomponents of the supply chain should be undertaken to understand how to obtain synergies from the drivers, overcome the barriers, and make trade-offs where necessary (Mollenkopf *et al*., 2010).Points of convergence have been identified and some principles could be either a driver or a barrier, depending how firms optimizes the trade-off between the two paradigm. It seems to be important to make an assessment of the points of convergence and divergence across these paradigms in terms of sustainable supply chain. Best practices could be identified for implementing leagile sustainable supply chain and could be driven by key performance indicators that could measure or monitor sustainable supply chain. The lack of commonality across drivers, barriers, convergences and contradictions could be explained by the different hybrid supply chain strategies and markets targeted by the companies.

CONCLUSION

An attempt has been made to present Lean, Agile and Leagile paradigms and the link between supply chain and sustainable development. Lean production and agile organization have impact on the sustainable supply chain and conversely. It seems that the only way companies can recognize and navigate trade-offs or conflicts in their supply chains is to treat sustainability as integral to operations (Lee, 2010). Key performance indicators and measurement methods like supply chain carbon footprint could provide some information about the implementation of these hybrid strategies, to ensure that all supply chain members meet agreed-upon sustainable standards and targets. However, lean production and agile organization should be integrated with a set of initiative from the sustainable supply chain strategy in order to develop a sustainable system approach culture. With this kind of approach, companies could improve both their sustainability and their overall performance.

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